



Transportation and Climate Change Resource Center

REAL SOLUTIONS FOR CLIMATE CHANGE

Climate Change 101: An Overview of Climate Change for State DOTs

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Overview

- I. Climate Change Science, Sources, and Trends
- II. The Importance of Climate Change to State DOTs
- III. Strategies to Reduce GHG Emissions from Transportation
- IV. Climate Adaptation for Transportation Agencies
- V. Climate Legislation and Policy

I. Climate Change - Science, Sources and Trends



What are the scientific findings?

Climate Change 2007: The Physical Science Basis

- Developed by the Intergovernmental Panel on Climate Change (IPCC)
- Contributions from 2,000 scientists assessing the Earth's environment and the effects of global warming

...a summary for policy makers...

There is 90% certainty that humans are the cause of global warming.



Notable findings in the report:

- Atmospheric CO₂ levels are at their highest levels in 650,000 years.
- Average global temperatures have risen ~1.3°F since the industrial age began.
- Sea level rose ~4.8 – 8.8" worldwide during the 20th century, at a rate more than double that of the past decade

How certain are the scientists?

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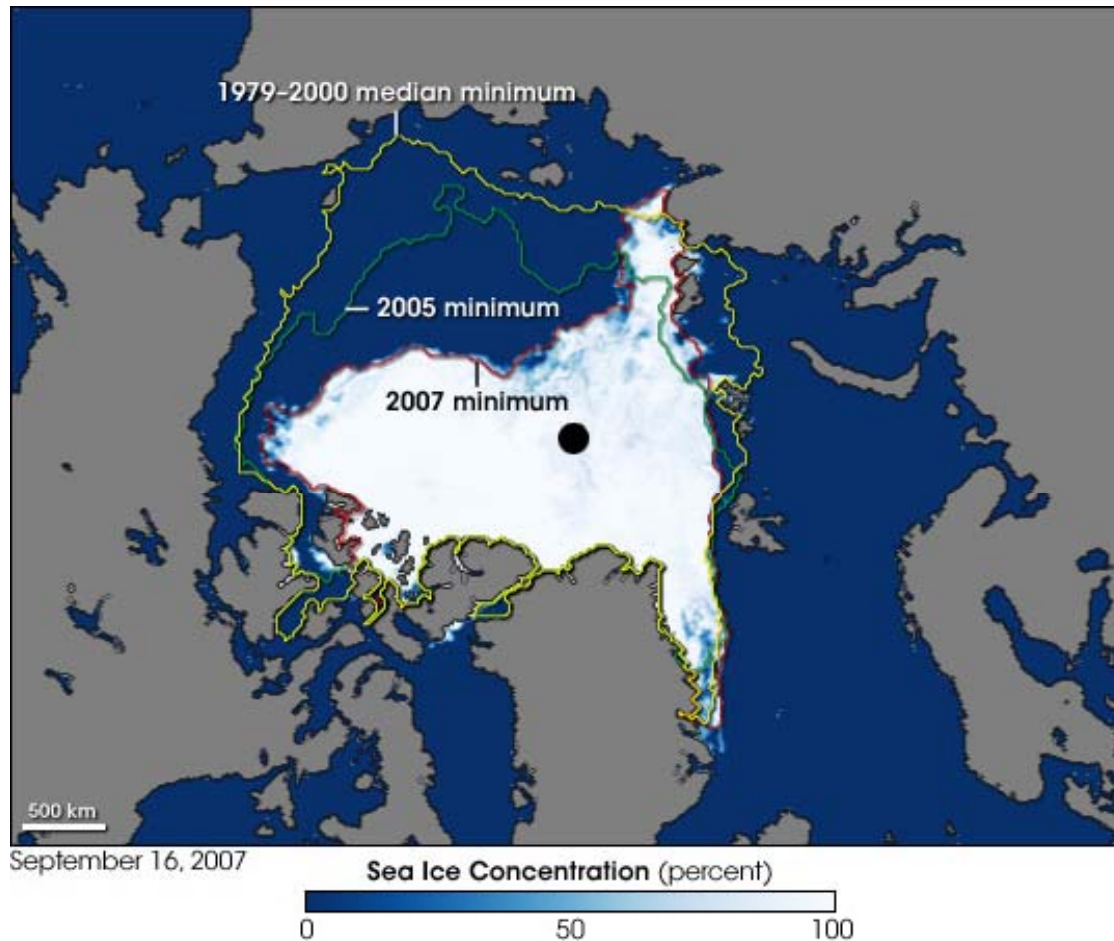
- “Warming of the climate system is unequivocal...”

-- Intergovernmental Panel on Climate Change

- “An overwhelming body of scientific evidence paints a clear picture: climate change is happening, it is caused in large part by human activity, and it will have many serious and potentially damaging effects in the decades ahead.”

-- Pew Center on Climate Change

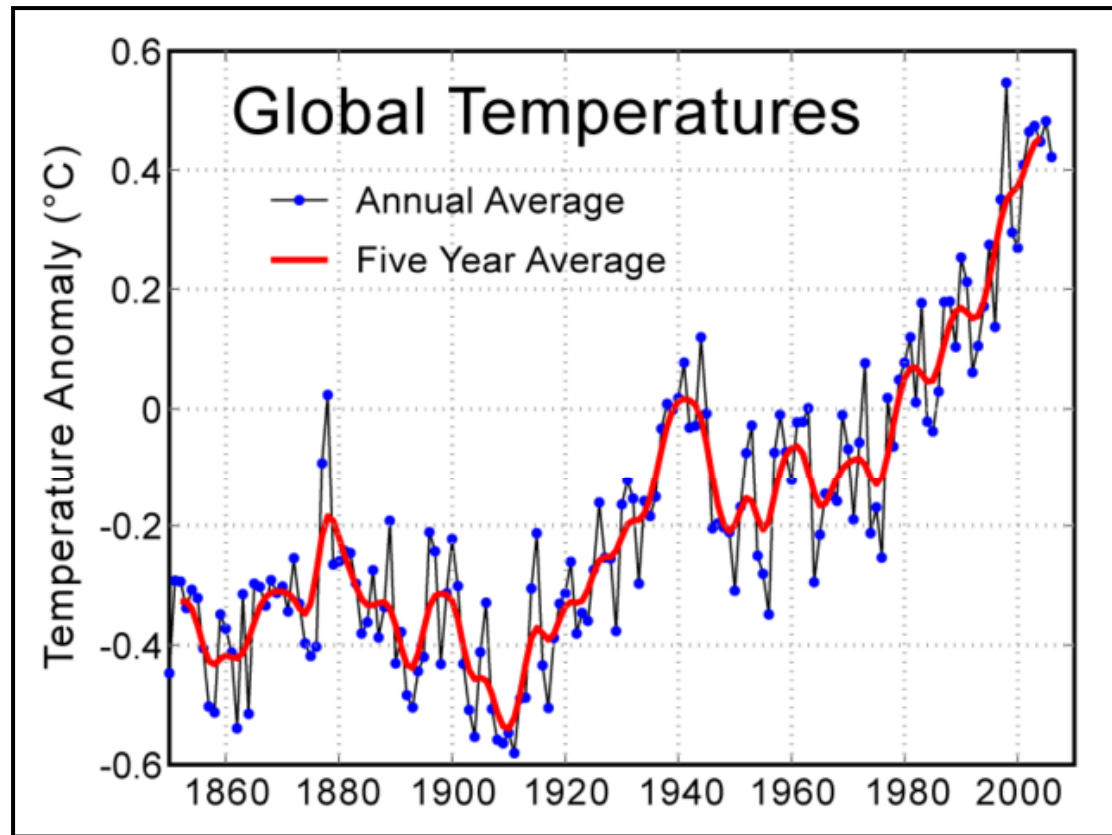
What is the physical evidence?



Source: NASA

- Arctic sea ice is retreating –
- a measurable change in climate that can be seen

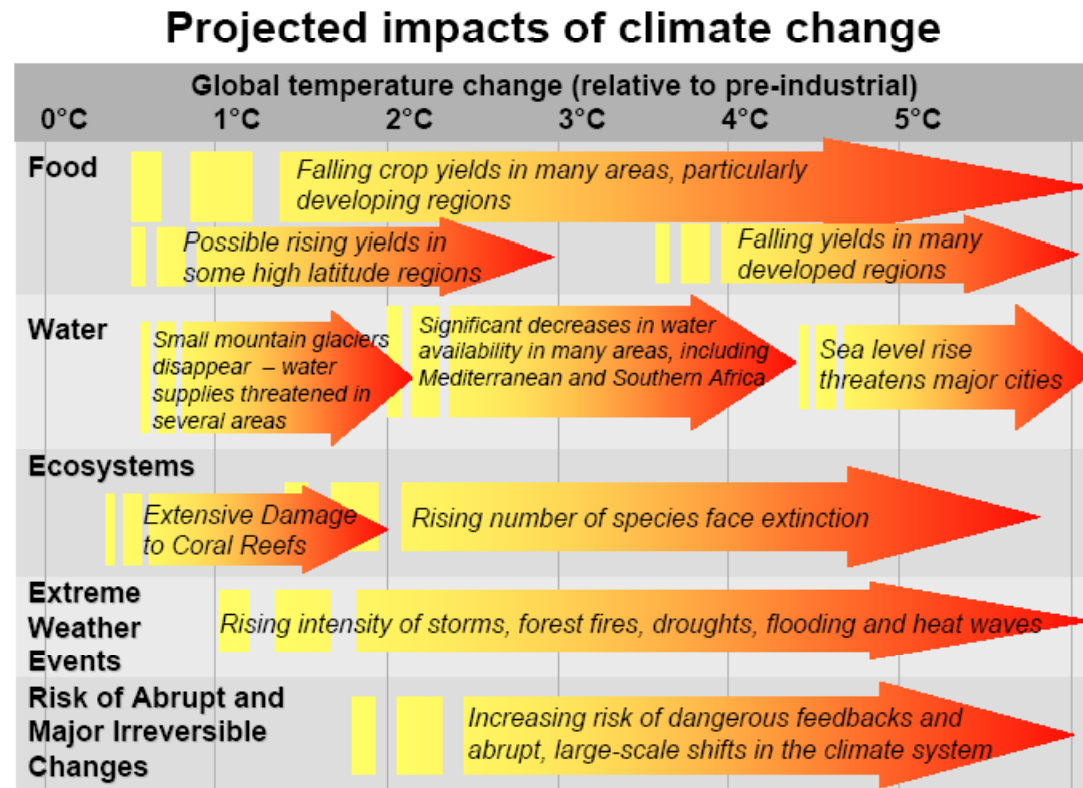
What is the evidence on temperatures?



Source:

http://www.globalwarmingart.com/wiki/Image:Instrumental_Temperature_Record_png

What are the impacts at different temperature increases?



Source:
Stern Review, 2008

How much GHG reduction is needed?

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- Scientists recommend **60-80% GHG emission reduction below 1990 level by 2050**
- Many states and countries have adopted targets in this range
- GHGs are cumulative, with a long half life (100 years)
- The longer we wait to make reductions, the deeper future cuts will have to be

II. The Importance of Climate Change to State DOTs

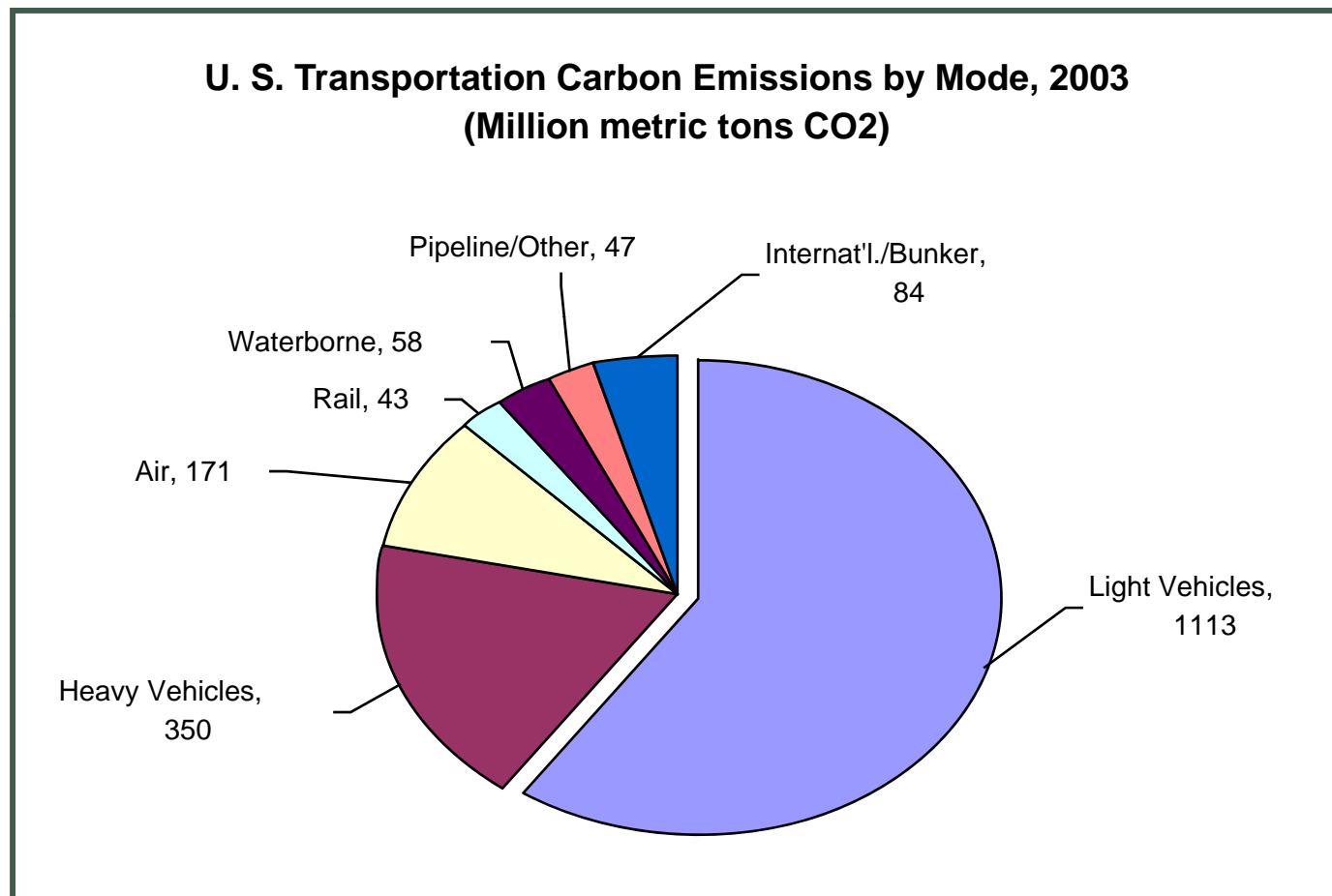


A Three-Part Challenge to State DOTs

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1. Reduce transportation GHG 60-80% by 2050
2. Adapt transportation infrastructure to rising sea levels, more severe storms, higher temperatures, and flooding
3. Find a new revenue stream suitable for low-carbon fuels

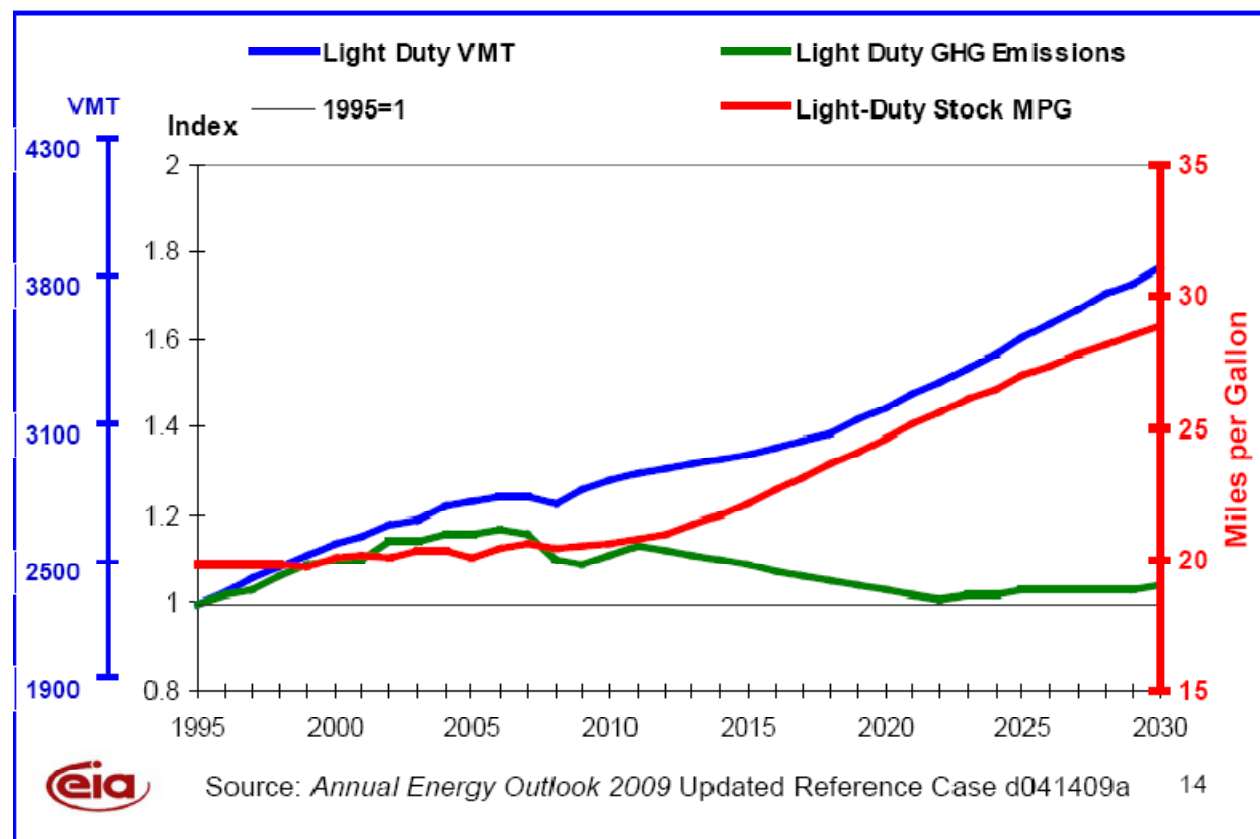
Highway Vehicles Account for 82% of Transportation CO2 Emissions – and 23% of all U.S. CO2



As VMT and MPG rise, GHG is nearly flat

-- for Light Duty Vehicles

Light Duty VMT, MPG, and GHG Emissions (3 of 3)



What should the GHG reduction target be for the transportation sector?

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- Economists:

- Reduce GHG emissions as cost-effectively as possible, even if that means much larger reductions in some sectors than others
- Evidence is accumulating that reducing transportation GHG 80% would be more costly than same % reduction in other sectors
- Ergo: Transportation GHG reduction targets probably should be lower

- Political reality:

- Transportation will be expected to contribute its "fair share"
- Room for debate about what "fair share" means.
- Often-cited goal is 60 to 80% from current levels.

III. Strategies to Reduce GHG Emissions from Transportation



Five GHG Reduction “Legs”

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Transportation GHG reduction has 5 legs:

1. Vehicles
2. Fuels
3. VMT
4. Operating Efficiency
5. Construction, Maintenance, and Agency Operations

Examples:

- Higher CAFE standards
- CA’s low carbon fuel standard
- Telework, trip-chaining
- ITS, Eco-driving
- LED traffic lights

Vehicle/Fuel Improvements Will be the Dominant Source of GHG Reductions for LDVs

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- 50% cut in GHG/mile is feasible from conventional technologies and biofuels by 2020-2030
- Compare these GHG rates in U.S. and Europe:

380 grams/mile	2009 in the U.S.
250 grams/mile	2016 under new Obama standard
256 grams/mile	2007 actual in the E.U.
209 grams/mile	2012 under E.U. regulation
153 grams/mile	2020 under E.U. regulation

Vehicle “decarbonization” is essential

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“In the long term, carbon free road transport fuel is the only way to achieve an 80-90% reduction in emissions, essentially “decarbonization.”

--The King Review for the U.K. Government, by
Professor Julia King, Vice-Chancellor of Aston
University and former Director of Advanced
Engineering at Rolls-Royce plc, March 2008

“[I]n the period beyond 2100, total GHG emissions will have to be just 20% of current levels. It is impossible to imagine this without decarbonization of the transport sector.”

-- Sir Nicholas Stern, Stern Review to the
U.K. Government, 2007

Trends in developing world underscore the need for vehicle/fuel decarbonization

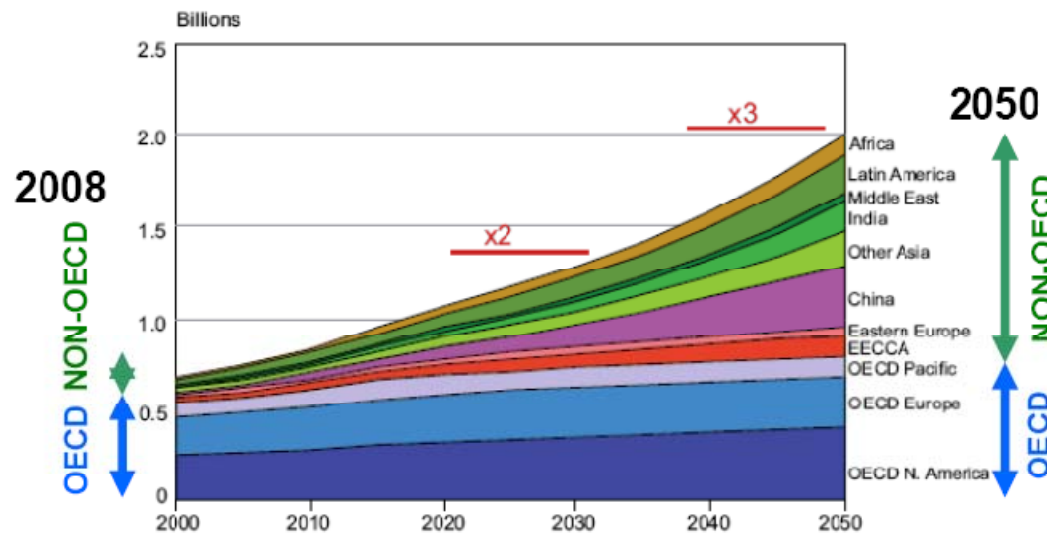


Figure 5.5: Total stock of light-duty vehicles by region
Source: WBCSD, 2004a.

Source: WBCSD, 2004a: Mobility 2030: Meeting the Challenges to Sustainability

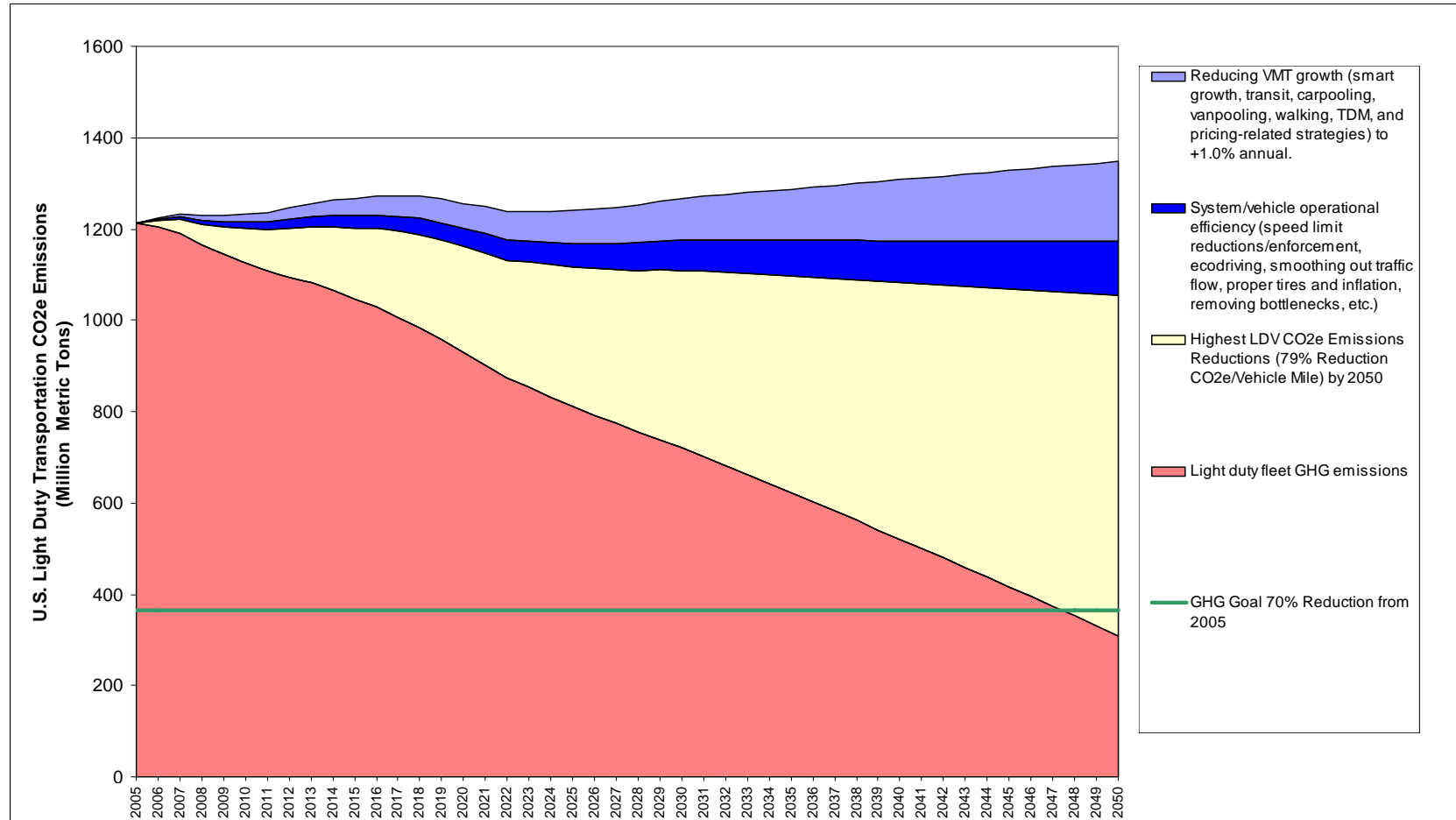
Possible State DOT Roles in Decarbonization

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1. Influence state policies on low-carbon fuels/vehicles
2. Plan/provide plug-in infrastructure for electric and PHEV vehicles
3. Support federal transportation funding for technology/fuel R&D
4. Educate the public
5. Provide incentives for consumers to use lower carbon fuels/vehicles (lower fees for low-carbon vehicles/fuels)
6. Use planning scenarios to emphasize need for decarbonization
7. Maximize use of low carbon vehicles/fuels in state DOT fleets

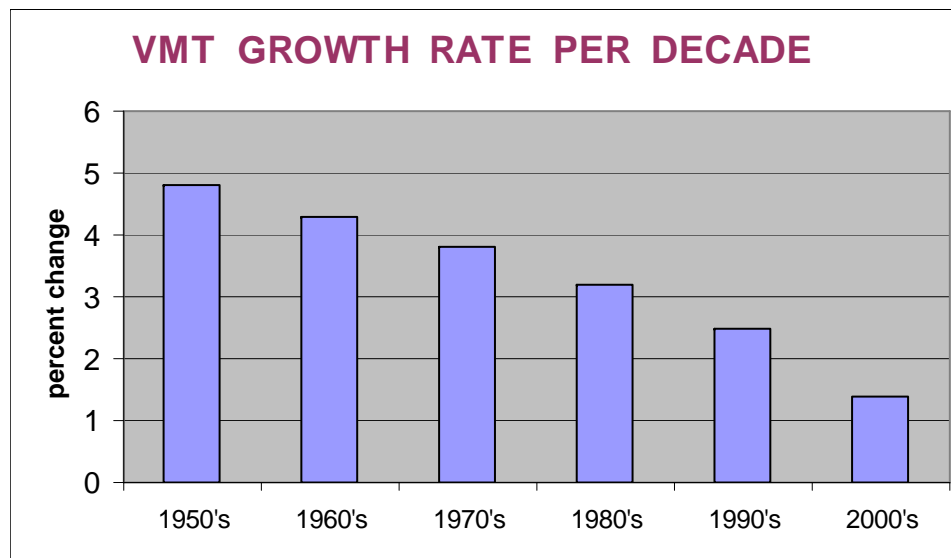
One Scenario to Achieve 74% LDV GHG Reduction by 2050

1% Annual VMT Growth + 100 mpgge LDV Fleet + 10% Operational Efficiency



U.S. VMT growth rates are declining– but will zero or negative VMT growth be expected?

- VMT growth has been steadily declining since the 1950s
- VMT growth slowed to about 1.5% in early 2000s
- AASHTO supports reducing VMT growth rate to 1% per year



Source: Alan Pisarski and Cambridge Systematics

Many Strategies to Reduce LDV VMT

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- Economy-wide carbon cap and trade (raises fuel prices)
- Transportation pricing (PAYD insurance, parking pricing, tolls, higher user fees, cordon pricing, congestion pricing, etc.)
- Carpooling and vanpooling
- Bike/ped
- Transit in high density corridors
- Trip chaining
- Tele-working, tele-shopping, tele-education, tele-medicine
- Compact land use

Pricing – A Necessary and Powerful Tool

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- Without price signals, trying to reduce GHG is swimming upstream
- Pricing encourages many helpful changes:
 - Consumer purchase of lower-carbon vehicles and fuels
 - Business investment in low-GHG technology
 - Lower VMT
 - Eco-driving
 - More efficient land use
- Many different pricing tools available: auto “feebates,” carbon/fuel prices, PAYD insurance, mileage fees, parking pricing, congestion pricing, etc.
- Pricing produces revenue to invest in alternatives

CO₂e Emissions Per Passenger Mile for Various Modes

NATIONAL AVERAGE	Energy Intensities		Load Factor	CO ₂ e
	(Btu or kWhr per vehicle mile)	(Btu or kWhr per passenger mile)	Persons Per Vehicle	(Estimated Pounds CO ₂ e Per Passenger Mile)
Single Occupancy Vehicle (SOV) LDVs	5,987	5,987	1.00	0.99
Personal Trucks at Average Occupancy	6,785	4,329	1.72	0.71
Transit Bus	37,310	4,318	8.80	0.71
Cars at Average Occupancy	5,514	3,496	1.57	0.58
Electric Trolley Bus	5.2	0.39	13.36	0.52
High Occupancy Vehicle (HOV) LDVs at 2+ Occupancy	5,987	2,851	2.10	0.47
Intercity Rail (Amtrak)	54,167	2,760	20.50	0.39
Light and Heavy Rail Transit	62,797	2,750	22.50	0.39
Motorcycles	2,226	2,272	1.20	0.37
Commuter Rail	92,739	2,569	31.30	0.36
Vanpool	8,048	1,294	6.10	0.21
Walking or Biking	-	-	1.00	0.00
REGIONAL EXAMPLE (SEATTLE/PUGET SOUND REGION)	Energy Intensities		Load Factor	CO ₂ e
	(Btu or kWhr per vehicle mile)	(Btu or kWhr per passenger mile)	Persons Per Vehicle	(Estimated Pounds CO ₂ e Per Passenger Mile)
Cars (64%) and Personal Trucks (36%) at Average Occupancy	5,987	4,468	1.34	0.74
King County Metro Diesel and Hybrid Buses	33,024	2,854	11.57	0.47
Sound Transit Buses	33,024	2,517	13.12	0.42
King County Electrically-Powered Trolley Buses	5.33	0.44	12.12	0.11

Carpooling and Vanpooling

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- Important but not appreciated (carpools/vanpools provide far more passenger miles than transit)
- Low cost for government, wide availability, saves users money
- Effective in all kinds of areas – rural, small urban, suburban, urban
- Near term payoff
- Atlanta and DC MPOs pay for commuters to carpool (\$2/day)

Transit helps reduce GHG – but 1-2% effect nationally

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- Transit serves many different goals, has broad support
- But as a national GHG strategy:
 - Transit serves 1% of PMT and 0% freight in the U.S.
 - DOE: Bus transit has higher GHG/passenger mile traveled than average auto use
 - APTA studies: (a) Transit reduced GHG by 6.9 MMT in 2005; or (b) by 35 MMT in 2005. This is 0.3% to 1.7% of U.S. transportation GHG
- Transit GHG benefits are realized with highly patronized services in high volume corridors -- a market limited to high volume, generally densely developed corridors

Land Use Effect on GHG Depends on Assumptions -- 3 studies, 3 results

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- ***“Growing Cooler”***: 3.5-5% reduction in transportation GHG, 2007-2050, with aggressive assumptions about land use change:
 - 67% of all development in place in 2050 will be constructed or rehabbed after 2005
 - 60-90% of that development is compact (13 housing-units per acre)
 - Compact development has 30% less VMT than very sprawling development
- ***“Moving Cooler”***: 2% on-road GHG reduction cumulatively, 2010-2040, if 90% of new urban land use is compact, bike/ped friendly, with high quality transit
- ***2009 TRB study***: <1 to 11%* reduction in passenger LDV GHG in the year 2050 from compact land use

* TRB panel split on whether 11% is possible

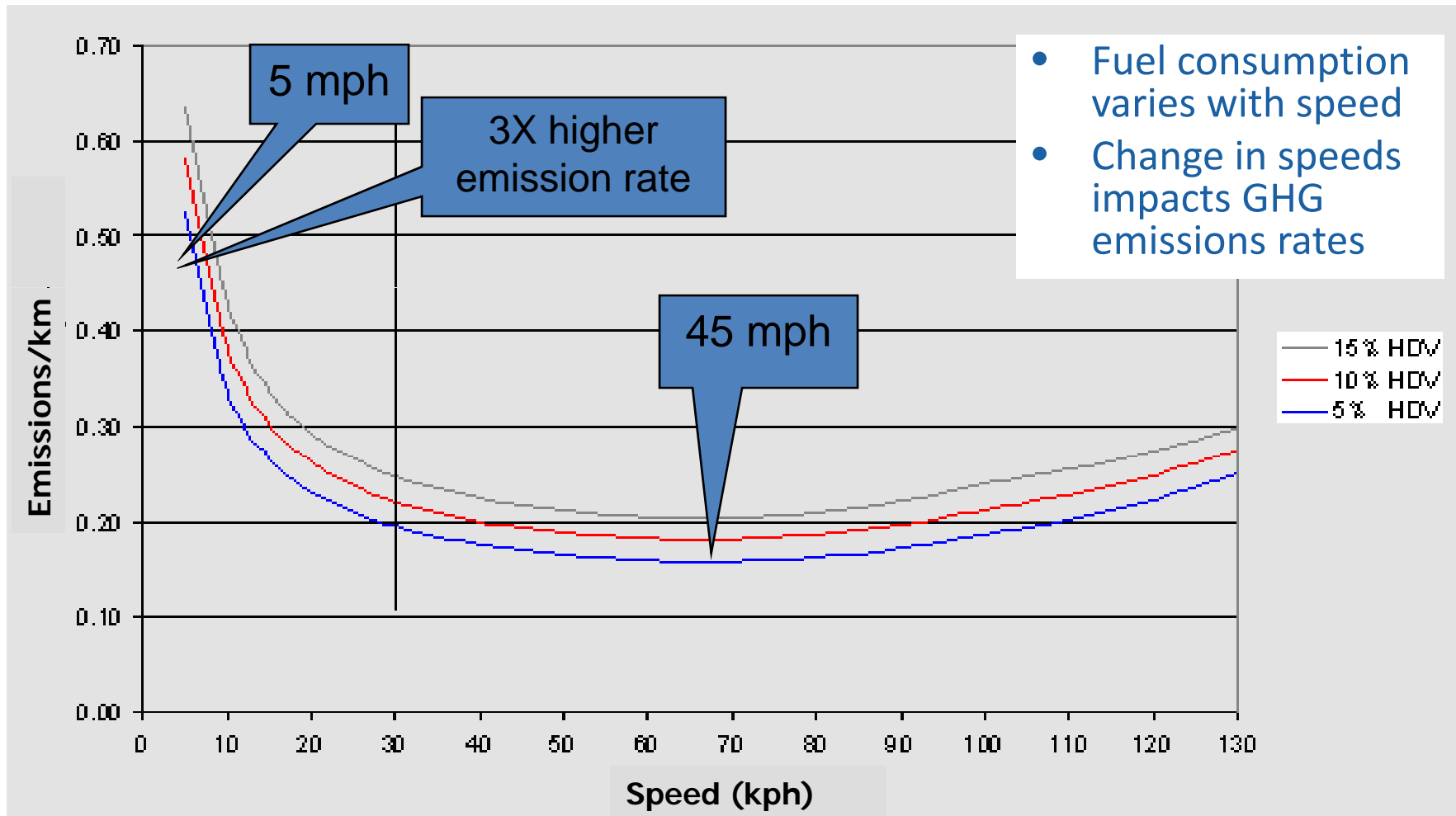
Vehicle/System Operations to Reduce GHG

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Potential for 10-20% LDV GHG reduction by:

- Managing speed (35-55 MPH is optimal)
- Speed limits/enforcement (could reduce fuel use 2-4%)
- Eliminating bottlenecks
- “Active” traffic management to smooth traffic flow
- Improving signal timing (could reduce 1.315 MMT CO₂/yr)
- Roundabouts (multiple benefits)
- Reducing car and truck idling
- Work zone management to smooth flow
- Encouraging eco-driving

How does speed affect GHG?



Source: Colin McConnaha, Parametrix, Inc.

Eco-Driving – 15% GHG Reduction Potential

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- EcoDrivers can reduce fuel and CO2 by an average of 15% through smart driving and vehicle maintenance
- If 50% of drivers practice EcoDriving, CO2 would drop by 100 million tons annually (the equivalent of heating and powering 8.5 million households)
- Pilot by City of Denver with 300 drivers achieved 10% fuel reduction and similar GHG reduction
- Useful for HDV, MDV, and LDV drivers
- Major push in Europe as GHG strategy
- Aided by dashboard displays of real-time MPG & other “smart” technology

www.EcoDrivingUSA.com

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- EcoDrivingUSA™ : A nationwide effort to increase overall vehicle fuel economy and preserve the environment
- Partnership of state Governors, environmental organizations, auto industry
- More info on EcoDrivingUSA™: www.EcoDrivingUSA.com
 - [Be an EcoDriver](#)
 - [EcoCalculator](#)
 - [EcoDriving Quiz](#)
 - [Virtual Road Test](#)
 - [Is Your Community EcoDriving?](#)
 - [Educational Tools](#)
 - [News and Events](#)
 - [Join the EcoDriving Movement](#)
- Compare these GHG reductions in “Moving Cooler,” for 2010-2050:
 - 1,815 MMT - If 20% of drivers adopt ecodriving
 - 1,445 MMT - If at least 90% of new urban development is compact, bike-ped friendly, with high-quality transit